Temperature Limits

Optional Fittings

There are a number of factors that determine the maximum temperature rating of a pressure vessel. For most applications it is the gasket material. Vessels with O-ring seals are limited to 225 °C unless exotic materials are used to extend this temperature to 275 °C. Parr's design for contained PTFE gaskets extends the operating temperature range to 350° C. Flexible Graphite (FG) material essentially removes the gasket as the limiting factor. Maximum temperature limits for the metals used in these vessels are established by the ASME and other standards. Most metals have maximum temperature limits between 400 and 800 °C. The allowable strength for these metals falls off rapidly as they reach maximum operating temperature. Finally, the difficulties encountered with screw threads and other closure components operating at high temperatures establish a practical temperature limit for externally heated vessels. We have found 600 °C to be a reasonable limit.

Internally Heated Vessels

Exposed Heaters. Another approach has proven useful in extending the maximum temperature limit. In this design the heater or furnace is placed inside the pressure vessel. This heater is surrounded by a layer of insulation. This creates a hot zone in the center of the vessel and prevents the walls from exceeding their allowable limit. Properly designed, temperatures as high as 1200° C are generated in the core of the vessel while the walls remain below 250° C. This system is very energy efficient. Internal heaters can be less powerful than external heaters. Internally heated vessels are equipped with insulated electrical feed throughs to power the heater and multiple thermocouples to monitor and control the temperatures in the hot zone and the vessel inner wall.

The reactions or studies carried out in internally heated vessels must be limited to those which will not destroy the exposed internal heaters and insulation. These are normally gas- solid reactions or controlled atmosphere heat treatment studies. The heating elements are normally ceramic. Some users have developed induction style heaters and insulators and have extended their investigations to above 2500 °C.

Although internal heaters can be installed in almost any non-stirred Parr pressure vessel the 1.8 liter, Model 4683 High Pressure/High Temperature vessel is an excellent starting point. It can accommodate a cylindrical, insulated heater 1.75 inch diameter by 8 inch deep, capable of producing and sustaining internal temperatures to 1200 °C.

Protected Heaters. Internally heated vessels have also been manufactured using cartridge type heating elements inserted in specially designed 'thermowells'. These wells protect the heater from the reactants and expand the applications that can be studied. Cartridge type heaters have a maximum temperature of 850 °C.